Postnatal growth and development pattern of camel calves

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Key words

Camelus bactrianus - Young animal - Growth - Biological development - China.

Summary

Thirty-two Bactrian camel calves kept under traditional management conditions were used to study postnatal growth and development patterns. Thirteen linear body measurements were taken at the intervals of 30 days after birth up to day 420. The mean growth rates for height, heart girth, length, cannon circumference, chest depth, chest width, croup height, croup width, croup length, leg length, head length, head width and neck length were measured. The results showed that to a large extent the different body dimensions maintained a uniform pattern of maturity and their ranking for earliness of maturity tended to remain constant throughout the observation period. The fast growth rates occurred when the calf had access to an adequate maternal milk supply. The live weight growth pattern followed that of most mammalian species. However, fast growth occurred during the first seven months after birth and the daily weight gain was at its highest at the third month with an average of 0.782 ± 0.349 kg. A negative weight gain was observed between the 10th and 11th months with an average of -0.1677 ± 0.19 for the males and of -0.006 ± 0.24 kg when it was the breeding season for the dam and milk production decreased. The mean daily weight gain during the observation was 0.3846 ± 0.2895 kgd^{-1}. The maturity degree with regard to body weight and age was deduced from standardized growth curves.

■ INTRODUCTION

The camel role in the modern world is changing as pastoral societies evolve or decline and the traditional use of the camel primarily as a transport animal is decreasing. However, there is a growing awareness of the food shortage facing the world. In the economic order of the world food strategy is now receiving the highest priority. It calls for consideration all means of production with cost minimization (9, 13, 14, 21). With the increasing use of Bactrian camels as meat suppliers, the growth physiology is becoming more attractive to many animal scientists.

Growth is determined by sex and genetic potential and mainly affected by nutrition and health status of the animals. An accurate estimation of growth is complicated by various natural processes or production and reproduction. The growth rate varies according to the availability of food and may be altered seasonally; especially in the camel outdoor feeding is a popular husbandry regime. Body weight is the most comprehensive measure of growth, but it is subject to short-term changes, in particular during pregnancy and lactation. Linear body measurements tend to be affected to a lesser extent by these factors and allow comparison of growth in different parts of the body.

Data of growth in dromedary camels has been reported extensively by many researchers (1, 4, 8, 10), but little data is available for the Bactrian camel. It is the purpose of this paper to present the basic data of linear body measurements and liveweight and investigate the postnatal development and growth pattern of Bactrian camel calves.

■ MATERIALS AND METHODS

Experimental animals

Thirty-two camel calves, 16 females and 16 males from artificially inseminated dams were used for body dimension and body weight measurements. Dams and calves were supplemented with grass hay in the winter and allowed free access to pasture throughout the year, with water available *ad libitum*.

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Body measurements and body weight

Height, heart girth, length, cannon circumferences, chest depth, chest width, croup height, croup width, croup length, leg length, head length, head width and neck length were recorded as previously reported (20). The newborn calves were weighed when dry and within twelve hours after birth in a suspended scale, then on a platform scale at intervals of 30 days until day 420. All data collected from individuals were pooled and presented as means plus or minus the standard error (± SE) for sexes against the days after birth.

Growth was described by monthly (30 days) body weight (W), average daily weight gain (ADWG) and weight per day of age (WPD, calculated as the actual weight divided by the days of life). Rough growth data were plotted. Linear regression equations were calculated for W, ADWG, WPD and body measurements on age.

The degrees of maturity (μ) for body height, heart girth and cannon bone circumference were calculated by dividing monthly values by values of mature animals. Maturity started at the point in time when the growth curve leveled off. The mature weight (A) was assumed as 600 kg and $A^{0.27}$ as 5.6247 accordingly. Body height, length, heart girth and cannon bone circumference at maturity were 168, 147, 202, 19.2 and 164, 144, 197, 17.5 cm for males and females, respectively (20).

μ, logμ, $W^{0.27}$, $\mu^{0.27}$ and log transformations were calculated according to Taylor (16, 18). The resulting values were plotted against age.

■ RESULTS

Changes in body measurements with age in male and female calves are plotted in figures 1 to 6. Regression equations of body weight changes and linear measurements on age are shown in table I. The degrees of maturity of body height, length, heart girth and cannon bone circumference are given in table II. Changes in body weight with age in male and female calves are plotted in figure 7. Pooled values and values by sex of calves of W, ADWG and WPD are presented in tables III and IV, and in figure 8.

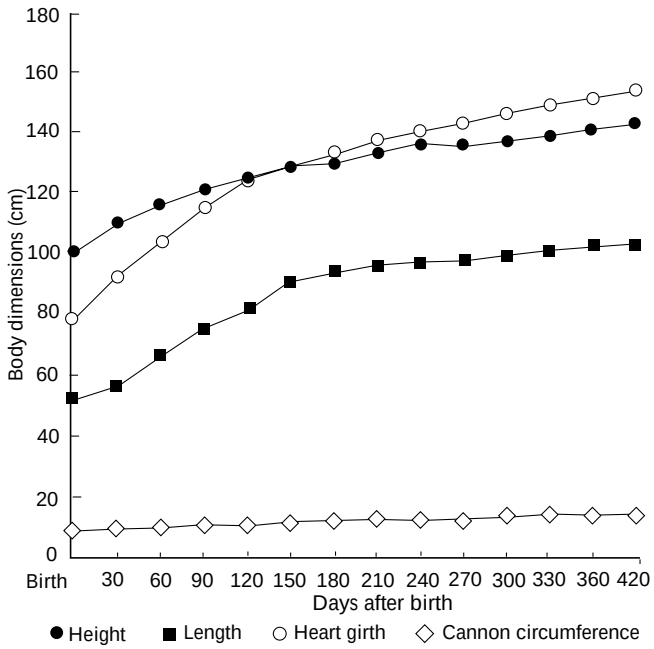

Figure 1: *Changes of height, length, heart girth and cannon circumference of male calves.*

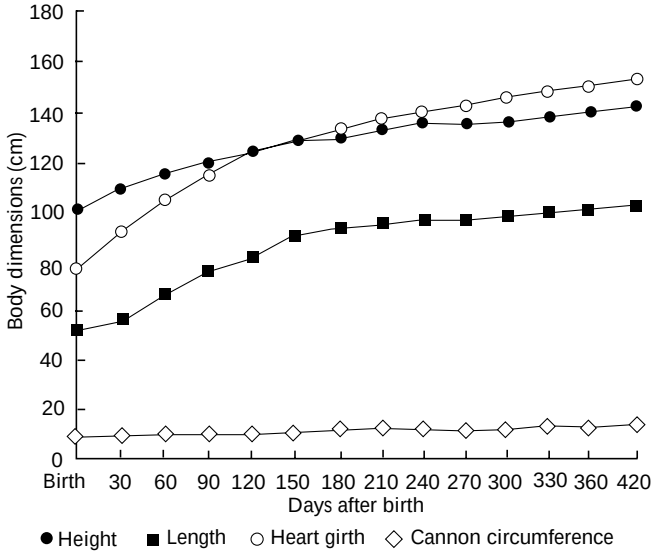

Figure 2: *Changes of height, length, heart girth and cannon circumference of female calves.*

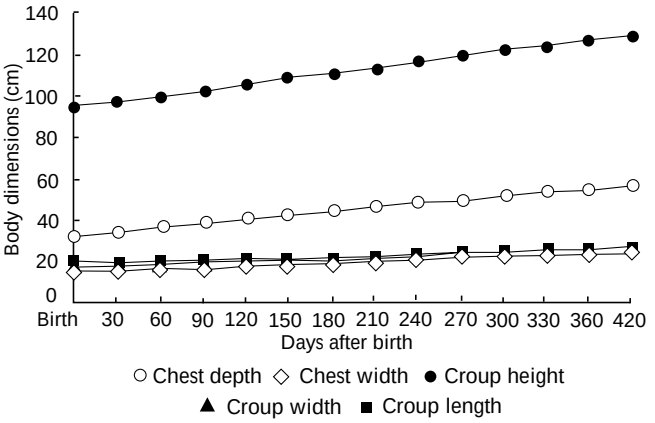

Figure 3: *Changes of chest depth, chest width, croup height, croup width and croup length of male calves.*

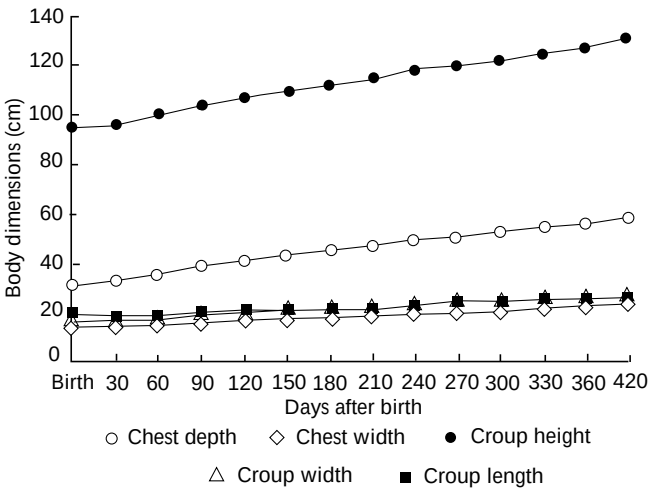

Figure 4: *Changes of chest depth, chest width, croup height, croup width and croup length of female calves.*

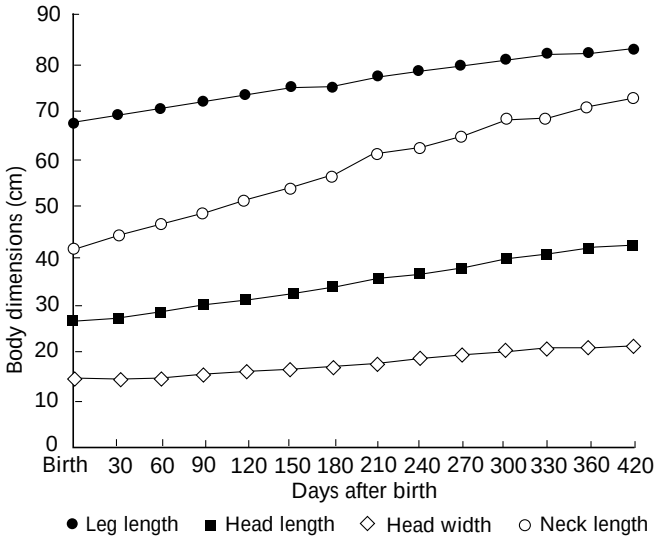

Figure 5: *Changes of leg length, head length, head width and neck length of male calves.*

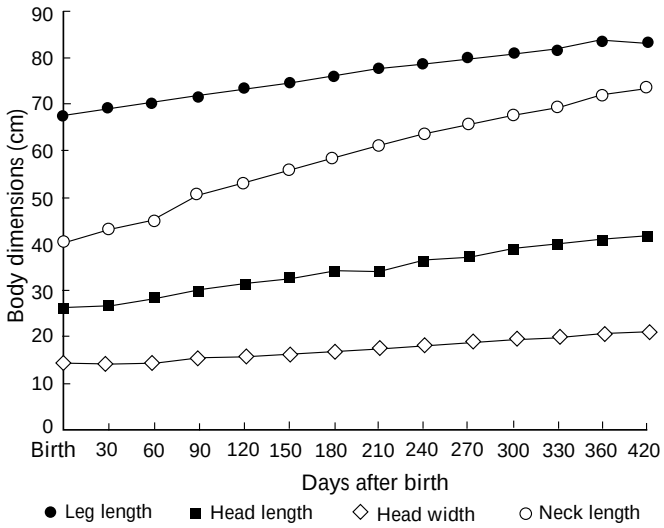

Figure 6: *Changes of leg length, head length, head width and neck length of female calves.*

Table I

Equations and correlation coefficients (r)

Body	Male		Female	
measurements	Regression equation	r*	Regression equation	r*
Height	Y = 109.78 + 0.9616x	0.9446	Y = 109.3 + 0.1004x	0.9405
Heart girth	Y = 94.753 + 0.191x	0.9405	Y = 93.906 + 0.1782x	0.9411
Length	Y = 61.445 + 0.1293x	0.9332	Y = 62.322 + 0.1265x	0.9078
Cannon circumference	Y = 9.4010 + 0.1277x	0.9777	Y = 9.544 + 0.01154x	0.9336
Chest depth	Y = 33.092 + 0.0618x	0.9963	Y = 32.608 + 0.0659x	0.9910
Chest width	Y = 14.530 + 0.2475x	0.9941	Y = 13.890 + 0.2317x	0.9979
Croup height	Y = 95.473 + 0.8779x	0.9978	Y = 95.207 + 0.8863x	0.9952
Croup width	Y = 16.564 + 0.2579x	0.9951	Y = 16.363 + 0.2640x	0.9959
Croup length	Y = 18.690 + 0.1756x	0.9848	Y = 18.583 + 0.1747x	0.9907
Leg length	Y = 68.511 + 0.3855x	0.9926	Y = 68.042 + 0.0415x	0.9906
Head length	Y = 26.267 + 0.04x	0.9961	Y = 26.226 + 0.0408x	0.9928
Head width	Y = 14.119 + 0.1789x	0.9962	Y = 13.671 + 0.1851x	0.9969
Neck length	Y = 42.299 + 0.7886x	0.9925	Y = 42.172 + 0.083x	0.9907
Body weight	Y = 61.922 + 0.3124x	0.9162	Y = 61.228 + 0.3342x	0.9021
Body weight log	Y = 1.7796 + 0.0014x	0.8573	Y = 1.7631 + 0.0016x	0.835
WPD	Y = 26.056 - 0.0922x	-0.4496	Y = 26.056 - 0.0922x	-0.4496
ADWG	Y = 25.498 - 0.0914x	-0.4437	Y = 25.645 - 0.0923x	-0.4479

* All statistically significant ($p < 0.01$), except those for WPD and ADWG

WPD = weight per day of age; ADWG = average daily weight gain

Table II

Degree of maturity of the traits (%)

	Height	Length	Heart girth	Cannon circumference
Male	59.89	35.36	38.63	47.05
Female	60.34	36.21	38.43	55.34
Average	60.11	35.73	38.53	51.19

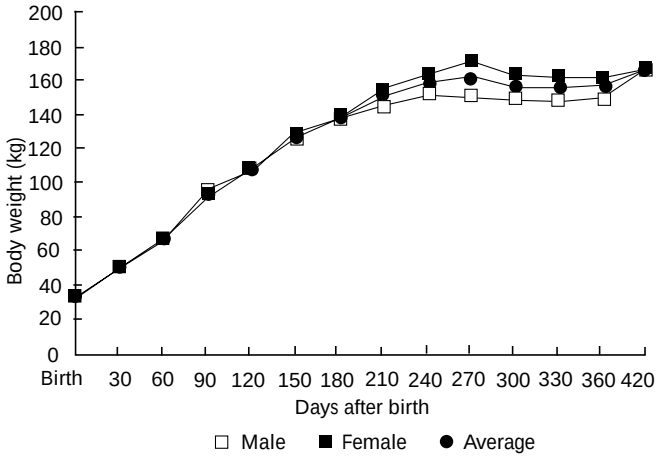

Figure 7: *Body weight changes of camel calves.*

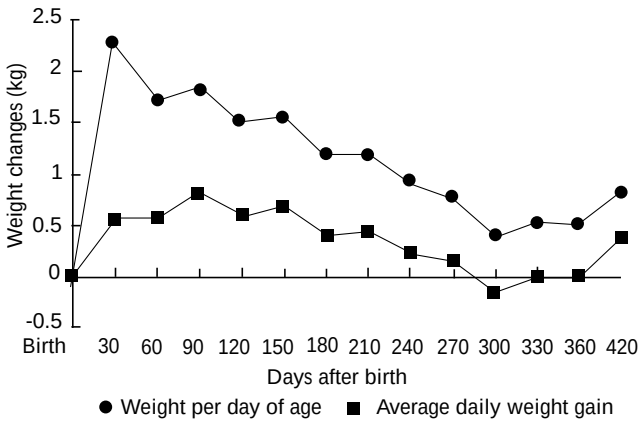

Figure 8: *Average daily weight gain and weight per day of age in camel calves.*

Table III

Pooled body weight, average daily weight gain (ADWG), weight per day of age (WPD), and standard error (SE) of male and female camel calves

Days after birth	Body weight		ADWG		WPD	
	Mean	SE	Mean	SE	Mean	SE
Birth	34.55	7.17	-	-	-	-
30	51.26	8.34	0.557	0.04	1.71	0.28
60	68.38	4.81	0.571	0.118	1.1396	0.16
90	91.83	10.48	0.782	0.349	1.020	0.27
120	109.13	14.73	0.5767	0.29	0.9094	0.09
150	129.15	17.32	0.667	0.17	0.861	0.07
180	140.6	19.63	0.3817	0.14	0.7811	0.087
210	153.52	27.15	0.431	0.17	0.7310	0.09
240	160.15	25.88	0.221	0.14	0.6673	0.12
270	163.99	26.58	0.128	0.09	0.6074	0.03
300	158.96	21.67	-0.1677	0.19	0.5297	0.04
330	158.77	22.68	-0.006	0.24	0.4811	0.04
360	159.45	23.27	0.02267	0.29	0.4429	0.092
420	170.457	21.99	0.3675	0.27	0.4059	0.14

* All statistically significant ($p < 0.01$), except those for WPD and ADWG

Table IV

Monthly weights of male and female calves (kg)

Days after birth	Male		Female	
	Mean	SE*	Mean	SE*
Birth	36.17	8.70	32.92	5.63
30	50.88	7.76	51.63	8.91
60	68.79	9.95	67.97	10.57
90	97.66	10.43	96.00	15.42
120	109.21	12.37	109.05	17.09
150	130.67	16.10	127.58	18.54
180	141.25	15.85	139.95	23.41
210	149.67	18.24	157.37	36.06
240	154.67	17.63	165.63	34.12
270	153.50	16.57	174.47	36.56
300	152.17	14.86	165.74	28.68
330	152.33	14.57	165.74	28.60
360	154.08	13.86	154.90	32.67
420	178.21	12.66	170.74	31.33

* Standard error

Body dimensions

The growth rates of height, length, heart girth and cannon circumferences increased significantly before day 150 ($p < 0.05$) (figure 1) and then increased gradually with few irregularities.

Mean growth rates of the height, length, heart girth and the cannon circumference during the experimental period of 420 days for male and female calves were 0.102 and 0.108, 0.138 and 0.126, 0.178 and 0.196, 0.01 and 0.009 cmd^{-1}, respectively. The Bactrian camel is generally thought to be mature at four years. Therefore, the degrees of maturity of height, length, heart girth and cannon circumference at birth for calves (table II) showed that the earliest maturing traits, the height and cannon circumference for male and female camels at birth were 56.89, 60.34, 47.05 and 55.34%, respectively.

Mean growth rates of chest depth, chest width, croup height, croup width and croup length of the male and female calves (figures 3 and 4) were 0.059 and 0.064, 0.022 and 0.022, 0.083 and 0.085, 0.024 and 0.025, and 0.016 and 0.015 cmd^{-1}, respectively. The differences between sexes were not significant ($p > 0.05$). Mean growth rates of leg length, head length, head width and neck length (figures 5 and 6) were 0.035 and 0.038, 0.037 and 0.037, 0.016 and 0.017, 0.072 and 0.079 cmd^{-1}, respectively.

Regression equations of W, ADWG, WPD and body measurements on age are presented in table I. Correlation coefficients (r) between postnatal age (days) and each body dimension were always highly significant ($p < 0.01$). The highest values of r in male calves were attained in the following order: chest height, chest depth, head width, head length, croup width, chest width, leg length, neck length, croup length, cannon circumference, height, heart girth and length. In female calves the order was: chest width, head width, croup width, croup height, head length, chest depth, croup length, neck length, leg length, heart girth, height, cannon circumference and length.

Body weight, average daily weight gain and weight per day of age

W, ADWG and WPD are shown in table III, figures 7 and 8. Birth weights averaged 34.55 ± 7.17 kg. Body weight changes of male and female calves are presented in table IV and figure 7. Body weight of males and females were 36.17 ± 8.70 and 32.92 ± 5.63 kg, respectively. Sex of the calves had no statistically significant effect on the birth weight, however, male calves were heavier than females before 210 days and the observed results were reversed afterwards.

The results indicate that during the 420 days of observation the fastest growth in calves occurred at the third month with an ADWG of 0.782 ± 0.309 kgd^{-1}; it then decreased gradually. A negative weight gain was observed at 10th month with an ADWG of -0.1677 ± 0.19 and -0.006 ± 0.24 kgd^{-1}, respectively. With the increase of age, WPD decreased gradually from 1.71 ± 0.20 kgd^{-1} at the first month to 0.4059 ± 0.14 kgd^{-1} at the 14th month. The mean value during the whole period was 0.3486 ± 0.2895 kgd^{-1}, for male and female calves, mean ADWGs were 0.4072 ± 0.3151 and 0.3332 ± 0.3553 kgd^{-1}, respectively.

Growth curves

Degree of maturity in body weight (μ) against age is shown in tables V and VI, and figure 9. Taking natural logarithms of μ gave a set of ($\log_e \mu$, t) curves (figure 9). The power transformation $\mu^{0.27}$ results in $\mu^{0.27}$, t (figure 10) curves. This transformation has the interesting property that both ordinate and abscissas are scaled by the same factor $A^{0.27}$. Thus, as a first approximation $W^{0.27}$, t curve (figure 9) is a simple photographic magnification of one another.

Other transformations were $\text{Log}_e[-\log_e(1-\mu)]$ ($\text{Log}_e[-\log_e(1-\mu)]$), t and $\text{Log}_e(-\log_e\mu)$ ($\text{Log}_e(-\log_e\mu)$, t) curves which appear to have the interesting property of being symmetrically in μ and 1-μ (figure 10).

Table V

Degree of maturity of body weight

Days after birth	μ	$\text{Log}_e\mu$	$W^{0.27}$
Birth	0.0576	-2.8542	2.6024
30	0.08543	-2.4733	2.8949
60	0.1140	-2.1716	3.1291
90	0.1531	-1.8767	3.3885
120	0.1819	-1.7043	3.5501
150	0.2153	-1.5357	3.7153
180	0.2343	-1.4512	3.8016
210	0.2559	-1.3630	3.8928
240	0.2669	-1.3209	3.9375
270	0.2733	-1.2971	3.9628
300	0.2649	-1.3284	3.9296
330	0.2646	-1.3246	3.9283
360	0.2658	-1.3250	3.9329
420	0.2841	-1.2584	4.0045

Table VI

Various transformed values of degree at maturity (μ)

Age	$\mu^{0.27}$	$\text{Log}_e[-\log_e(1-\mu)]$	$\text{Log}_e(-\log_e\mu)$
Birth	0.4627	-2.8247	1.0488
30	0.5147	-2.4157	0.9002
60	0.5564	-2.1116	0.7754
90	0.6024	-1.7947	0.6295
120	0.6311	-1.6056	0.5332
150	0.6606	-1.4169	0.4290
180	0.6758	-1.3206	0.3724
210	0.6921	-1.2188	0.3097
240	0.7000	-1.1697	0.2783
270	0.7045	-1.1418	0.2601
300	0.6986	-0.7897	0.2840
330	0.6983	-1.1797	0.2848
360	0.6992	-1.1745	0.2814
420	0.7119	-1.0958	0.2298

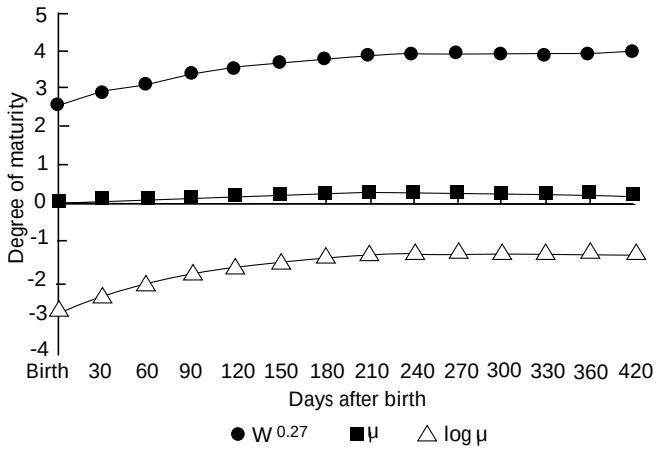

Figure 9: *Degree of maturity in Bactrian camel calves.*

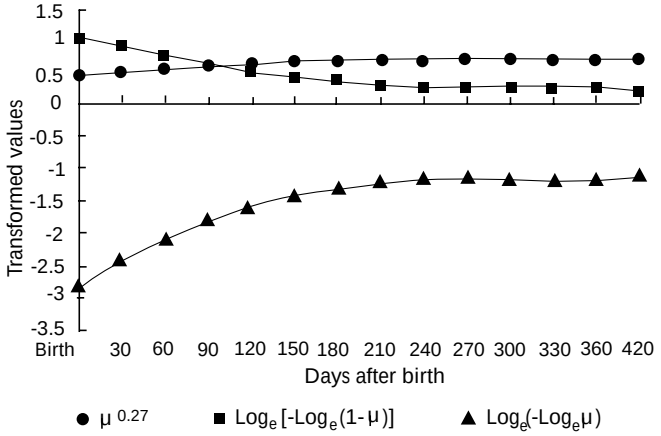

Figure 10: *Various transformed curves in Bactrian camel calves.*

■ DISCUSSION

The scaled variables μ and time after birth were subject to a number of mathematical transformations in order to give various sets of transformed standardized growth curves with different properties. They could help to understand the set of curves, and also to allow better use to be made of them for various purposes.

For any transformations of the variable μ, the growth of animals and also the mean growth curves can be represented in principle by some form of growth equation. As illustrated with the estimated mean species growth curve for the variables $\log_e(-\log_e\mu)$ by Taylor (17), the transformed growth in this study was more or less a linear pattern over the observation period.

Mathematical models to describe the growth of plants, animals and tissues have been developed and reviewed by many researchers (6, 19). The analyses of components of growth curves, such as functional growth rates and estimates of mature body size, are being examined by animal geneticists as potential tools to aid in the selection of animals having specific growth related traits. An extension of the use of growth curves to compare animals across species, breeds or sexes has been termed genetic size scaling (15, 16). Through size scaling growth curves can be calculated for different species and standardized for degree of mature body weight and metabolic age. Comparison across species revealed sigmoid growth curves of a similar shape, but significant deviations from the mean species curve were noted and it was indicated that all species do not reach the same fraction of their mature size at a given metabolic age (18).

Postnatal growth in animal is characterized by continued growth of the skeleton, musculature and organs until the animal reaches approximately 50-60% of its mature weight and then skeletal and organ weight gains have slowed down and fat deposition has increased to a modest rate (19). However, in Bactrian camels this point in time was after 2 years of age, which is rather long compared with other animals (21).

The birth weights of the dromedary were studied by many researchers. Bhargava *et al.* reported for Indian Bikanieri camels a range of 26.3 to 52.15 kg (1). The average birth weight of males was 38.19 kg and of females 37.19 kg, with a pooled average of 37.23 kg. In his study, which involved 134 records over a three-year period, the sex of the calves, calving sequences and month of calving had apparently no statistically significant effect on the birth weight. The results were similar to the current research. The sex of the calf, however, has often be found to be a significant source of variations in other species. Brinks *et al.* are among the many researchers who have showed it to be a significant source of variations in bovine birth weights, irrespective of the age of the dam (2).

Heredity is another factor affecting prenatal growth, directly *via* the genotype of the fetus and indirectly through the genotype of the dam. A positive correlation exists between the maternal body size and the prenatal growth of the fetus. The birth weight is influenced by the sum of factors contributing to the nutrition of the fetus in the uterus. Hansard and Berry summarized the factors influencing the birth weight of the animals and estimated that the largest component of variation (36%) is attributed to the combined genotypes of the dam (20%), fetus (17%), parity (7%), nutrition (6%), sex (2%) and the maternal age (1%). The extract role of these factors in the camel has not been investigated (7).

The nutritional status of the dam may also have a direct effect on fetal growth, a factor that would seem to be important in the camel; poor nutritional levels during gestation may lead to increased prenatal mortality. Nevertheless, Musa studied the development of the camel fetus and its associated growth curve, concluding that there was a striking similarity with the pattern of cattle (11, 12). The early postnatal growth is also influenced by the accessibility to the dam's milk. It is indicated in this research that a negative weight gain occurred when milk production decreased.

Burgemeister studied the weekly postnatal growth performance of dromedary calves. The results showed that male calves tend to grow faster than females (3). Similar growth patterns were also observed in the current research. Field (5) studied the growth patterns of two groups of camel calves, one under Rendille pastoral conditions and another under special project conditions whereby the young received as least 75% of their dam's milk. The former group showed average daily gain of 222 and 255 g during the dry and the wet seasons, which was similar to the results of current observation. Gains ranged from 378 to 655 g for the latter group, higher than that in the present research, which means that management and nutrition play an important role in growth. These

figures reflect the important influence of dam milk on growth and indicate the negative effects of competition for milk between calf and man under the pastoral management system. The postnatal calf growth curves given by Field also show a better performance by calves born during the wet season, irrespective of the breeds of the camel. However, their advantage is not permanent, since calves born in the dry season appear to catch up after 9-12 months by means of compensatory growth.

Acknowledgments

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REFERENCES

1. BHARGAVA K.K., SHARMA V.D., SINGH M., 1965. A study of the birth weight and body measurements of the camel *(Camelus dromedarius). Indian J. vet. Sci*., **35**: 358-362.

2. BRINKS J.S., CLARK R.J., RICE F.T., KIEFTER M.M., 1961. Adjusting birth weight, weaning weight and preweaning gain for sex of calf in range Hereford cattle. *J. Anim. Sci.*, **26**: 363-367.

3. BURGEMEISTER R., 1975. Elevage de chameaux en Afrique du Nord. Eschborn, Germany, GTZ, p. 40-48.

4. FAZIL M.A., 1977. The camel. *Bull. Anim. Health Prod. Afri*., **25**: 435-442.

5. FIELD C.R., 1984. Camel growth and milk production in Marsabit district, Kenya. In: Cockrill W.R., Ed., The camel: an all-purpose animal. Uppsala, Sweden, Scandinavian Institute of Africa Studies, p. 209-230.

6. GRIEEZE J.E., ALLEN D.M., 1969. Analysis of growth and dose response curves. *Biometrics*, **23**: 357-361.

7. HANSARD S.L., BERRY R.K., 1969. Fetal nutrition. In: Hafez E.S.E., Dyer I.A., Eds., Animal growth and nutrition. Philadelphia, PA, USA, Lea and Febiger, p. 238-247.

8. KNOESS K.A., 1977. The camel as a meat and milk animal. *World Anim. Rev*., **22**: 3-8.

9. LEUPOLD J., 1968. Le chameau, important animal domestique des pays subtropicaux. *Cah. bleus vét*., **15** : 1-6.

10. LAKOZA I., 1962. A valuable source for production of meat, milk and wool. *Konevodstro*, **12**: 2-5.

11. MUSA B.E., 1984. Summary of studies on reproduction in the dromedary. In: Cockrill W.R., Ed., The camel: an all-purpose animal. Uppsala, Sweden, Scandinavian Institute of Africa Studies, p. 360-363.

12. RUSSEL W.S., 1975. The growth of Ayrshire cattle: an analysis of liner body measurements. *Anim. Prod.*, **21**: 217-226.

13. SCHWARTZ H.J., DIOLI M., 1992. The one-humped camel in Eastern Africa. Berlin, Germany, Verlag Jusef Margraf, p. 30-61.

14. SHALASH M.R., 1984. The production and utilization of camel meat. In: Cockrill W.R., Ed., The camel: an all-purpose animal. Uppsala, Sweden, Scandinavian Institute of African Studies, p. 231-247.

15. TAYLOR S.C.S., FITZHUGH H.A., 1971. Genetic relationship between mature weight and time taken to mature within a breed. *J. Anim. Sci*., **33**: 726-731.

16. TAYLOR S.C.S., 1980. Genetic size-scaling rules in animal growth. *Anim. Prod*., **30**: 161-165.

17. TAYLOR S.C.S., 1980. Genetically standardized growth equations. *Anim. Prod*., **30**: 167-175.

18. TAYLOR S.C.S., 1980. Live-weight growth from embryo to adult in domesticated mammals. *Anim. Prod*., **31**: 223-235.

19. TRENKLE A.H., MARPLE D.N., 1983. Growth and development of meat animals. *J. Anim. Sci*., **57** (Suppl. 2): 273-283.

20. XUE H.W., ZHANG Y.K., ZHAO X.X., 1997. Growth and development pattern of the neonate Bactrian camel *(Camelus bactrianus)*: an analysis of linear body measurements. *J. Camel Pract. Res*., **4**: 61-65.

21. ZHAO X.X., 1995. Ecophysiology and reproduction in the camelidae. Lanzhou, Gansu, China, Gansu Science and Technology Press, p. 1-28.

Résumé

Zhao X.X., Xue H.W., Nie Q.C., Zhang Y.K. Croissance post-natale et profil de développement des chamelons *(Camelus bactrianus)*

Trente-deux chameaux de Bactriane élevés dans des conditions traditionnelles d'élevage ont été suivis pour étudier leur croissance post-natale et leur profil de développement. Treize mesures corporelles linéaires ont été faites à trente jours d'intervalle depuis la naissance jusqu'au 420^{e} jour. Les taux moyens de croissance pour la hauteur, le tour de poitrine, la longueur, la circonférence de l'os canon, la profondeur et la largeur du poitrail, la longueur et la largeur de la croupe, la longueur des pattes, la longueur et la largeur de la tête et la longueur du cou ont été évalués. Les résultats ont montré que, dans une large mesure, les différentes dimensions corporelles avaient un profil de maturité uniforme et que leur hiérarchie tendait à rester constante pendant toute la période d'observation. Les taux de croissance rapide correspondaient à un allaitement maternel satisfaisant. Le profil de croissance du poids vif suivait la courbe de la plupart des mammifères. Cependant la croissance a été plus rapide au cours des sept premiers mois et le gain de poids moyen quotidien (gmq) le plus important a été constaté au cours du 3^{e} mois, avec une moyenne de 0,782 ± 0,349 kg. Un gmq négatif a été observé entre le 10^{e} et le 11^{e} mois avec une moyenne de -0,1677 ± 0,19 kg pour les mâles et de -0,006 ± 0,24 kg pour les femelles, lorsque la mère entrait en période de reproduction et que la production laitière chutait. Le gmq moyen sur 420 jours a été de 0,3846 ± 0,2895 kgd^{-1}. Les courbes de croissance standardisées ont permit de déduire le degré de maturité en termes de poids vif et d'âge.

Mots-clés : *Camelus bactrianus* - Jeune animal - Croissance - Développement biologique - Chine.

Resumen

Zhao X.X., Xue H.W., Nie Q.C., Zhang Y.K. Patrón de crecimiento y de desarrollo postnatal en camellos jóvenes

Se utilizaron 32 camellos bactrianos, mantenidos bajo condiciones de manejo tradicionales, esto con el fin de estudiar los patrones de crecimiento y desarrollo postnatales. Se tomaron trece medidas corporales lineares, a intervalos de 30 días, desde el nacimiento hasta el día 420. Se midieron las tasas promedio de crecimiento para altura, circunferencia torácica, largo, circunferencia al cañón, profundidad pectoral, anchura del pecho, circunferencia a la cruz, altura a la cruz, altura del miembro posterior, largo de la cabeza, ancho de la cabeza y largo del cuello. Los resultados muestran que en gran medida, las diferentes dimensiones corporales mantienen un patrón uniforme de madurez y su rango para madurez temprana tiende a permanecer constante a lo largo del periodo de observación. Se observaron tasas de crecimiento rápidas cuando el camello tuvo acceso a un suplemento de leche materna adecuado. El patrón de crecimiento en peso vivo siguió aquel de la mayoría de las especies de mamíferos. Sin embargo, el crecimiento rápido se presentó durante los primeros siete meses después del nacimiento; la ganancia de peso diaria tuvo un punto máximo al tercer mes, con un promedio de 0,782 ± 0,349 kg. Entre el 10 y el 11 mes se observó una ganancia de peso negativa, con un promedio de -0,1677 ± 0,19 para los machos y de -0,006 ± 0,24 kg durante la estación de apareamiento para las hembras, con una disminución de la producción de leche. La ganancia diaria de peso promedio durante el estudio fue de 0,3846 ± 0,2895 kgd^{-1}. El grado de madurez con respecto al peso corporal y la edad se dedujo de curvas de crecimiento estándar.

Palabras clave: *Camelus bactrianus* - Animal joven - Crecimiento - Desarrollo biológico - China.